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EXPERIMENTAL INVESTIGATION OF LASER TECHNIQUE TO OPTIMIZATION OF LASER PROCESSING PARAMETER

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Abstract - *The project is about optimization of sheet metal cutting parameter of a laser machine. Several optimization techniques used for the determination of optimum laser cutting condition have been critically examined. This works aim that the effect of laser machine processing parameters, such as the laser power, cutting speed, and gas pressure, focal on measured surface roughness for the laser cutting of stainless steel & mild steel sheet.*

The main objective was to identify the most common process parameters and cut quality characteristics. Taguchi method stresses the importance of studying the response variation using the signal–to–noise (S/N) ratio, resulting in minimization of quality characteristic variation due to uncontrollable parameter. The performance of laser cutting process mainly depends on laser parameters. It shows that by proper control of the cutting parameter, good quality cuts are possible at high cutting rates. Therefore, it is important to investigate the impact of cutting parameters on quality of cut.

Key words: CO_2, Laser, Optimization, Process parameters, Software Minitab17, Taguchi Method.

1. INTRODUCTION

Sheet metal of stainless steel and mild steel are the project material on which we perform the practical in order to study the effect of variation of the parameters.

Following is the study:

1. Keeping thickness of sheet metal constant.
2. Then laser power constant.
3. Effect of different gas used in laser cutting and there function.
4. Effect of focal point on cutting parameters.
5. Effect on surface roughness.

1.1. Laser

Laser (Light Amplification by Stimulated Emission of Radiation)is a coherent and amplified beam of electro-magnetic radiation

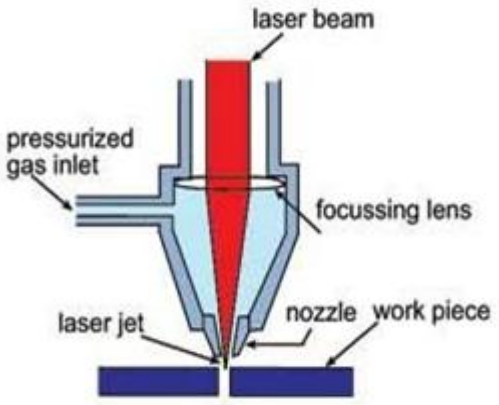

Fig. 1.1 Laser Machine

1.2. Laser Cutting Process

Laser cutting is a common manufacturing process employed to cut many types of materials. Materials which may be cut included ferrous metal, non ferrous metal, stone, plastic, rubber and ceramic. Laser cutting works by coordinating a high power beat laser at a particular area on the material to be cut. The vitality shaft is consumed into the surface of the material and the vitality of the laser is changed over into the warmth, which dissolve or vaporize the material. Also gas is engaged or blown into the slicing district to oust or overwhelm the liquid dissolve and vapor from cutting way.

There are a few favorable position of laser cutting over mechanical cutting, since the cut is performed by the laser bar, there is no physical contact with the material hence sullies can't enter or insert into the material. Laser cutting can create brilliant cut, complex cut, cut a few section at the same time ,deliver clean bleeding edge which require insignificant completing and also low edge stack amid cutting which will lessen contortion

Laser cutting is a genuinely new innovation that enables metals to be cut with outrageous exactness. The laser bar is ordinarily 0.2 mm in width with an energy of 1-10 kW, Depending on the use of the laser shaper a choice of various gases are utilized as a part of conjunction with the cutting. When cutting with oxygen, material is scorched and vaporized when warmed by the laser pillar to start temperature.

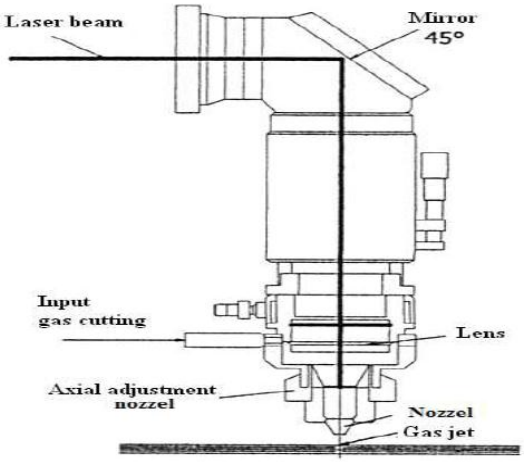

Figure no. 1.2: Laser Machine

Laser is an effective wellspring of light having unprecedented properties which are not found in the typical light sources like tungsten lights, mercury lights, and so forth. The interesting property of laser is that its light waves travel long separations with e almost no dissimilarity.

If there should be an occurrence of a regular wellspring of light, the light is discharged in a scatter of e isolate waves that cross out each other indiscriminately and subsequently can travel short separations as it were.

A relationship can be made with a circumstance where an expansive number of rocks are tossed it into a pool in the meantime. Every rock produces its very own rush. Since the rocks are tossed indiscriminately, the waves created by every one of the stones cross out each other and therefore they travel a short separation as it were. Then again, if the stones are tossed into a pool one by one at a similar place and furthermore at consistent interims of time, the waves along these lines produced reinforce each other and travel long separations. For this situation, the waves are said to movement intelligently. In laser, the light waves are precisely in advance with each other and accordingly have a settled stage relationship.

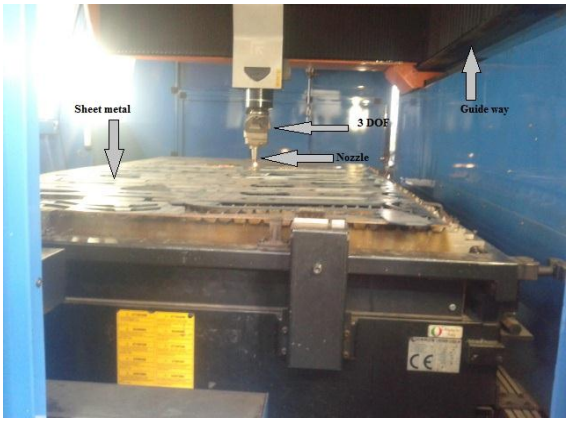

Figure no. 1.3 Experimental Setup of 3D Laser Cutting Machine

1.3 Problem Statements

Limit Surface unpleasantness of sheet influenced by process parameters. Streamlining is finished by utilizing "Taguchi technique", with the guide of Minitab programming.

1.4 Objective

There are 2 fundamental targets in this examination:

[a] To decide the improve parameters in cutting procedure.

[b] To break down the parameters by utilizing Taguchi Method.

[c] To investigation of the Laser Beam Cutting (LBC) on Acrylic Sheet.

[d] To locate the best parameters that can create the finest and most nature of cutting quality on Acrylic sheet by examination.

1.5 Scope of Study

The extent of study is separated in three segments:

(a) Process parameters,

(b) Sheet metal cutting and,

(c) Taguchi strategy.

1.6 Taguchi Designs

Genichi Taguchi, a Japanese specialist, proposed a few ways to deal with test plans that are once in a while called "Taguchi Methods." Taguchi proposed a few ways to deal with test outlines called Taguchi technique. This technique uses an orthogonal exhibit, which is a type of fragmentary factorial outline containing an agent set of all conceivable blend of trial conditions. Utilizing Taguchi technique, an adjusted examination of levels of the procedure parameters and critical diminishment in the aggregate number of required recreations can both be accomplished.

Utilization of T.M. is gone for the accompanying goals:

1.To set up the best or the ideal condition for an items or a procedure.

2.To gauge the commitment of individual parameters.

3.To gauge the reaction under the ideal conditions.

1.7 RESEARCH METHODOLOGY

Parameters to be optimized,

List of Parameters	Description
Laser Power	= MS 1400 Watt ,SS 2400 Watt
Cutting Speed	= MS 1500 mm/min, SS 3000 mm/min

TypeandPressureof Assist Gas	= MS (Oxygen-10 bar),SS (Nitrogen-10 bar)
Material Thickness	= MS (0.5-8 mm), SS (0.5-20 mm)
Mode of Operation	= MS/SS(CW)
Cutting Angle	= 00, 20, 40, 60
Nozzle Gap	= 1mm, 2.5 mm, 4.5mm, 6.0mm

2. EXPERIMENTAL WORK

2.1 RELATION BETWEEN CUTTING SPEED AND LASER POWER

a) Cutting speed: - sheet metal cut speed by a laser in mm/min.
b) Laser power: - power assisted by laser to penetrate and cut the sheet in watt.

2.1.1 EXPERIMENT NO. 1

Table No.1 General Data of Process Parameter

Material thickness (mm)	2	4	6	8
Gas pressure (bar)	10	10	7	7
Laser power (watt)	700	800	800	900
Cutting speed (mm/min)	3000	1800	1000	800

2.1.2 EXPERIMENT NO. 2

At constant thickness, to check other process parameter such as Laser Power and cutting Speed.

a) Material – Mild Steel
b) Assist gas pressure – 10 Kpa

2.1.2.1. For 2mm Thickness of Sheet

Table no. 2

Laser Power(watt)	Cutting Speed(mm/min)
400	800
500	1000
600	1500
700	2500
800	3000

2.1.2.2. For 3mm Thickness of Sheet

Table no. 3

Laser Power(watt)	Cutting Speed(mm/min)
400	600
500	800
600	1000
700	2000
800	2500

2.1.2.3. For 4 mm Thickness of Sheet

Table no. 4

Laser Power(watt)	Cutting Speed(mm/min)
500	300
600	500
700	800-900
800	1000-1200
900	1500(MAX.)

Thus from above we come to know that, if we increased Laser Power then increase cutting speed at constant thickness

2.1.3 EXPERIMENT NO. 3

a) For Stainless Steel Material

For constant laser power variation of cutting speed with respect to thickness of sheet

2.1.3.1For 400 watt power

Table no. 5

Thickness(mm)	Cutting Speed (mm/min)
2	1500
4	800
6	200-250

2.1.3.2.For 500 watt power

Table no. 6

Thickness(mm)	Cutting Speed (mm/min)
2	2000
4	1200
6	800

2.1.3.3. For 700 Watt Power

Table no. 7

Thickness(mm)	Cutting Speed (mm/min)
2	3000
4	1400
6	1000

b) For mild steel material :

2.1.3.4. For 400 Watt Laser Power

Table no. 8

Thickness(mm)	Cutting Speed (mm/min)
2	800
4	300
6	50-90

2.1.3.5. For 500 watt power

Table no. 9

Thickness(mm)	Cutting Speed (mm/min)
2	1000
4	300
6	100-150

2.1.3.6. For 700 watt power

Table no. 10

Thickness(mm)	Cutting Speed (mm/min)
2	2500
4	2000
6	800

From above experiment we come to know that cutting speed decreases with increase in material thickness at constant power supply

3. METHODOLOGY

3.1.1 Experimental Plan and Details:

In this investigation, three machining parameters were chosen as control factors, and every parameter was intended to have three levels, signified 1, 2, and 3 (Table 1). The trial configuration was by a L'9 cluster in view of Taguchi strategy, while utilizing the Taguchi orthogonal exhibit would extraordinarily diminish the quantity of analyses. An arrangement of analyses planned utilizing the Taguchi strategy was led to examine the connection between the procedure parameters and reaction factor. Minitab 17 programming is utilized to advancement and graphical examination of got information.

Process parameter and levels

Table no. 11 Process parameter and levels

Symbol	Process parameter	Level 1	Level 2	Level 3
P	Laser Power(kw)	1600	1800	2000
V	Cutting Speed (mm/min)	900	1200	1500
G	Gas pressure (mm)	14	15	16

4. TAGUCHI METHOD:-

The nature of configuration can be enhanced by enhancing the quality and efficiency. Vigorous outline is a building system for getting item and process condition, which are insignificantly delicate to the different reasons for variety, and which create top notch items with low improvement and assembling costs. Taguchi's parameter configuration offers a straightforward, deliberate approach and can diminish number investigation to improve outline for execution, quality and cost. Surface harshness has gotten genuine consideration for a long time.

It has planned a vital outline highlight much of the time, for example, parts subject to weariness loads, exactness fits, latch openings, and tasteful prerequisites. Notwithstanding resiliences, surface harshness forces a standout amongst the most basic limitations for the choice of machines and cutting parameters. A significant number of studies have researched the general impacts of the speed, encourage, and profundity of cut at first glance unpleasantness. Process displaying and advancement are the two essential issues in assembling items.

A more noteworthy consideration is given to precision and surface unpleasantness of item by the business nowadays. Surface complete has been a standout amongst the most imperative contemplations in deciding the machining capacity of materials. Surface harshness and dimensional exactness are the vital elements required to foresee machining exhibitions of any machining tasks.

Enhancement of machining parameters builds the utility for machining financial matters, as well as expands the item quality as it were. In this unique circumstance, an exertion has been made to assess the surface harshness utilizing exploratory information. Since turning is the essential activity in the vast majority of the creation forms in the business, surface complete of turned parts has more noteworthy impact on the nature of the item. Surface

complete in turning has been observed to be affected in differing sums by various factors, for example, sustain rate, work material qualities, work hardness, shaky developed edge, cutting velocity, profundity of cut, cutting time, apparatus nose range and device forefront edges,

4.1.Taguchi Orthogonal Array:

In the event that there is an analysis having 3 factors which have four esteems, at that point add up to number of test is 81. At that point aftereffects of all analysis will give 100 exact outcomes. In contrast with above technique the Taguchi orthogonal cluster make rundown of nine tests in a specific request which cover all components.

4.2. Experimentation: -

The entire experimentation is separated into various advances. Every one of the means are talked about in detail underneath:

4.2.1 Maximum Limits of Operating Parameters

There are three machining parameters i.e. laser control, cutting pace, gas weight. Distinctive investigations are finished by differing one parameter and keeping other two settled so most extreme estimation of every parameter was acquired. Working reach is found by testing with to plaser power and taking the lower levels of other parameters. A blend of every one of the three parameters is found past which device or occupation falls flat.

4.2.2Experiment Performed:-

Examinations are performed by the chosen outline of test parameter as appeared in Table. Machining time is noted by stopwatch and estimated last surface complete of all occupations.

4.2.3. Observation

In the run nine experiments are performed and surface finish is calculated. This is given in below table no.12AQ

Sr.no	Laser Power (kw)	Cutting speed (mm/min)	Gas pressure (bar)
1	1600	1000	0.5
2	1600	800	0.6
3	1600	600	0.7
4	1800	1000	0.5
5	1800	800	0.6
6	1800	600	0.7
7	2000	1000	0.5
8	2000	800	0.6
9	2000	600	0.7

5. STUDY ON EFFECT OF GAS USED IN LASER BEAM MACHINE AND SELECTION OF FOCAL POINT

5.1 Gas Study

a) N2 gives preferred surface complete over O2 [2].

b) N2 is utilized to cut stainless steel sheet on the grounds that N2 give white slice because of its purity[2].

c) O2 is utilized to cut mellow steel sheet [2].

d) (CO2(12%)+He(64%)+ N2(24%)) used to make laser for cutting reason [2].

(O2 , N2) used to make weight. N2 used to make laser is unadulterated N2[2].

5.2 Focal Point

a) The profundity of infiltration is relative to measure of energy yet additionally rely upon area of point of convergence [4].

b) For M.S. sheet central is sure i.e. over the sheet metal, while for S.S sheet central is negative i.e. beneath or center of the metal sheet[4, 5].

6.RESULT

Sr. No.	Laser Power	Cutting speed	Gas pressure	Surface roughen -ss	S/N Ratio
1	1600	1000	0.5	2.116	-7.458
2	1600	800	0.6	2.032	-6.158
3	1600	600	0.7	2.357	-6.667
4	1800	1000	0.5	1.952	-6.584
5	1800	800	0.6	2.667	-7.436
6	1800	600	0.7	1.958	-6188
7	2000	1000	0.5	2.791	-8.293
8	2000	800	0.6	2.225	-7.694
9	2000	600	0.7	1.882	-5.493

7. ADVANTAGES

1.No Direct Contact With Workpiece

2.Driliing Of Micro Hole Is Possible

3.No Effect On Properties Of Workpiece

4.No Burr And Chip Formation

5.Suitable For Machining Of Metal And Non Metal

8. SUMMARY

In this venture, playing out the test on Laser Beam Machine, we can locate the ideal machining parameter which influences the surface complete of the work piece. And furthermore the impacts of machining parameters on S-N proportion i.e. flag to commotion proportion.

In this investigation, the Gray social based Taguchi strategy was connected for the different execution qualities of cutting activities. A dim social examination of the surface unpleasantness acquired from the Taguchi technique diminished from the various execution qualities to a solitary execution trademark which is known as the dim social review. Hence, the streamlining of the muddled different execution qualities of the procedures can be enormously improved utilizing the Gray social based Taguchi technique. With this work we came to know considered that the cutting parameters like focal point, cutting velocity and laser control extraordinarily influences on laser cutting task, which by implication influences the - 9surface unpleasantness esteems. It is additionally demonstrated that the execution qualities of the cutting tasks, such as the surface harshness might be improved by utilizing this strategy.

Affirmation

We accept the open door to express our profound feeling of appreciation and entire hearted on account of our regarded guides Prof. Kumavat M.M., for priceless direction, motivation and consolation throughout the work. We are enormously in wrangled to them in steering us at whatever point we confront challenges in our work.

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